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TREE PLANTING in the GREAT PLAINS REGION

IN THE TREELESS Great Plains Region, trees and shrubs are essential to the making of a real home. The first step in forest planting should be to provide a windbreak or shelter belt to afford protection from the winds. Then a woodlot should be started for the production of fence posts and fuel.

Only proven hardy species should be chosen for planting. A number of trees can be grown successfully and will greatly enhance the value of the farm.

A large proportion of the failures in plantations is caused by the negligence of planters.

Thorough preparation of the soil, spring planting, and thorough cultivation of the soil after planting are the essential requisites for success.

Protection should be afforded against cattle, rodents, insects, and fires.

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TREE PLANTING IN THE GREAT PLAINS REGION.

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CONTENTS.

OBJECTS OF PLANTING.

TREES AND SHRUBS are essential to the making of a real home. They increase the value of the property and make conditions more pleasant and healthful. There is scant comfort in a house or barnyard exposed to the chilling winds and drifting snows of winter and the withering blasts of a hot, dry wind in summer.

The absence of tree growth has been a hindrance to the most rapid development of the region known as the Great Plains. Many of the early settlers, tired of the struggle against rigorous climatic conditions, have sold out and departed; but those who have remained, together with the more permanent farmers who always follow the first settlers, are gradually developing their farmsteads as homes. Substantial frame houses and improvements are slowly replacing the "soddies" and "dugouts" of the early days. The building of good roads, the general use of the automobile, and the insistence of farm wives and children upon some of the modern conveniences are causing many farmers to realize the necessity of having real homes.

On the average farm in the Plains region the first step in planting should be to provide a windbreak or shelter belt, which will afford protection from severe winds and furnish shade and comfort to both man and beast. To be effective, the shelter belt must be dense,

NOTE.—Acknowledgment is made of suggestions and advice in the preparation of this bulletin from E. F. Chilcott, superintendent, Woodward Field Station, Woodward, Okla.; Beyer Aune, superintendent, Bellefourche Experiment Station, Newell, S. Dak.; W. J. Morrill, State forester of Colorado, Fort Collins, Colo.; W. P. Snyder, superintendent, State Experiment Station, North Platte, Nebr.; R. J. Pool, professor of botany, University of Nebraska, Lincoln, Nebr.; Jay Higgins, forest supervisor, Halsey, Nebr.; and H. C. Hilton, forest supervisor, Laramie, Wyo.

and the farmer must not expect to secure any great amount of wood from it for farm use, as removing much large material or even trimming the branches may lessen or even destroy the protective value of the windbreak.

In addition to the shelter belt for the protection of the farm buildings, garden, orchard, and stock-feeding yards, every farm should have a wood lot for raising fuel, posts, and perhaps a limited amount of poles and saw-log material. The high price of coal and the low value of farm products at times have caused many farmers in portions of the Great Plains, especially those situated a considerable distance from the railroad, to burn corn. During periods of hard times some have been obliged to use cow chips for fuel as the early settlers used buffalo chips. (Fig. 1.) The continuation of these practices is for the most part unnecessary, since the comparative ease with which poplars or other fast-growing

FIG. 1.—Ranch house in western Nebraska. No comfort; cow chips for fuel.

species can be grown in much of the region makes it possible for farmers to have a supply of wood for fuel. (Fig. 2.) If good care is given the trees, they will develop rapidly. Some will have to be cut out to prevent harmful crowding. The material thus removed will furnish posts and fuel. When the plantation is still older, larger and more valuable products may be harvested, such as small telephone poles for farmers' lines, small timbers, and miscellaneous material for general use around the farm.

THE GREAT PLAINS.

The Great Plains extend from about the 99th meridian west to the foothills of the Rocky Mountains. They include roughly the western half of North and South Dakota, Nebraska, Kansas, Oklahoma; the "panhandle" of Texas as far south as the southern line of New Mexico; and the eastern Plains region of Montana, Wyoming, Colorado, and New Mexico. (Fig. 3.) This embraces approximately

400,000 square miles. or a territory equal to all of New England and the Atlantic Coast States, including Florida. The elevation of the Great Plains varies from 1,300 feet above sea level on the Missouri River in South Dakota to about 7,000 feet in southeastern Wyoming and on the Arkansas divide in Colorado.

CLIMATE.

The climate is characterized by a light rainfall and a comparatively high wind velocity with its accompanying high rate of evaporation. Wind, in fact. is the limiting factor in tree growth in the higher portions of the Plains, particularly in southeastern Wyoming. The northern Plains are subject to extremes of temperature both in summer and winter, and hail storms are common throughout the region. Taken altogether, the climate is so very difficult that trees can be raised on dry-land sites only with special care.

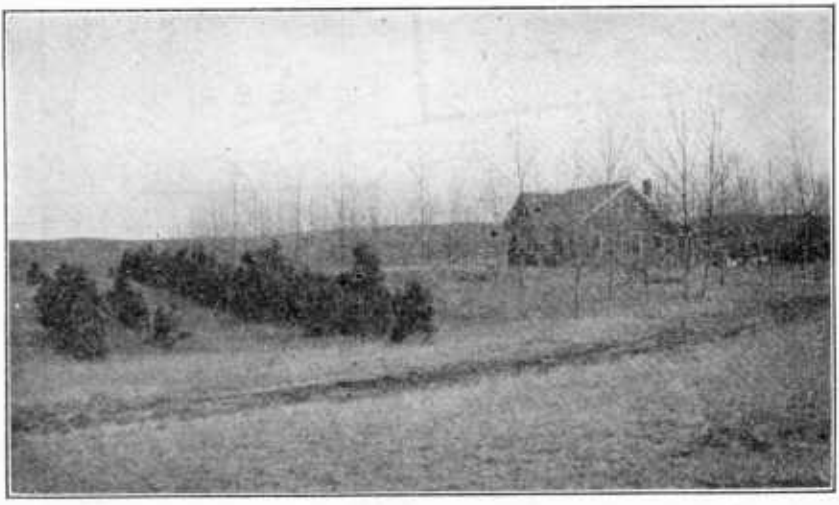

FIG. 2.—Carolina poplar and western yellow pine planted. Thomas County, Nebr. Comfort arrived; wood for fuel on the way.

SOILS.

The types of soil that characterize this area range from pure sand in the sand hills of Nebraska, through sandy loam, loess, silt, and clay loam to heavy gumbo clay and shales. In some sections an impervious layer of cemented gravel or heavy clay a few feet beneath the surface prevents the ready passage of soil moisture to or from the lower depths. This, of course, would limit the root system of the tree to the upper levels of the soil and make it dependent almost wholly on rainfall for water. There are also some localities where alkaline salts are present in the soil to such an extent as to prevent the growth of trees.

SECTIONS.

For the planting of trees, this region may be divided into the northern, central, and southern Great Plains. The northern Great Plains includes roughly the western parts of North and South

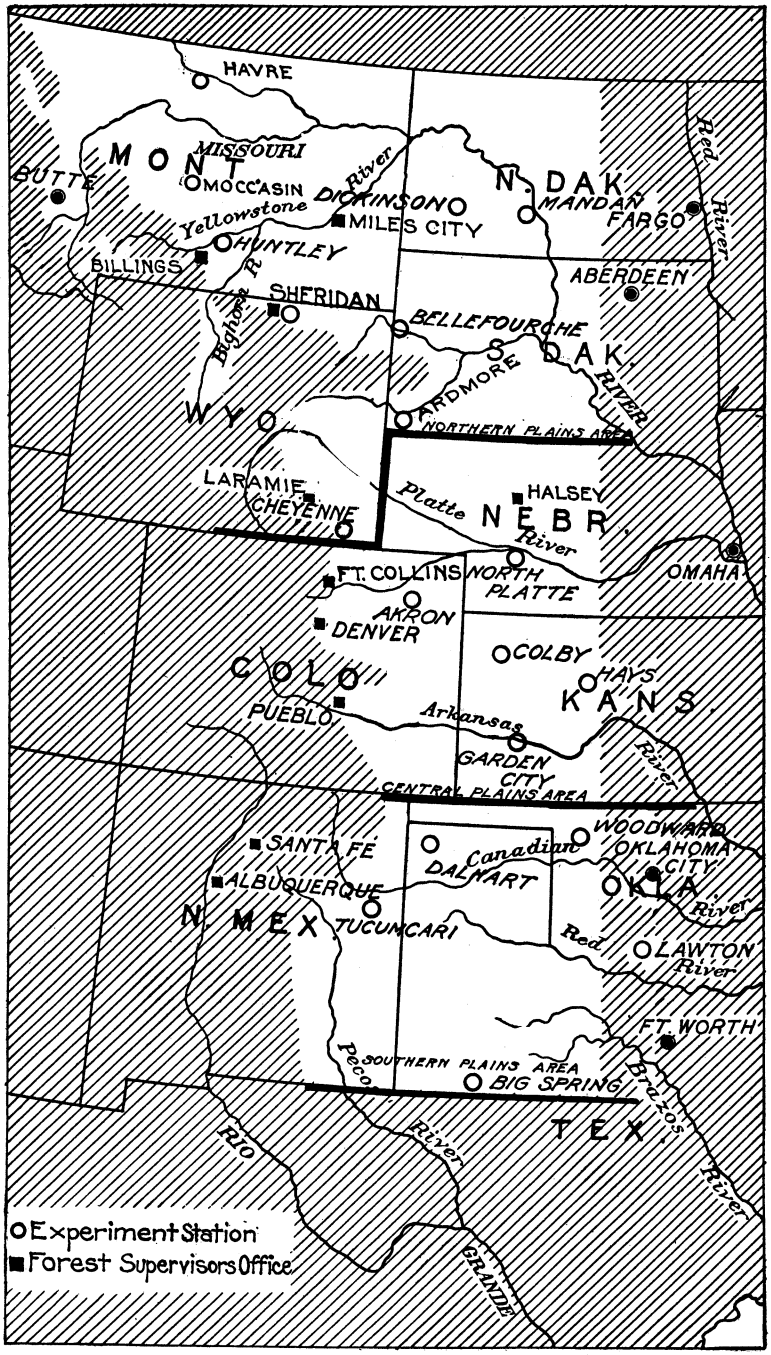

FIG. 3.—Sketch map of Great Plains.

Dakota and the plains sections of Montana and Wyoming. The central Great Plains includes western Nebraska and Kansas and eastern Colorado. The southern Great Plains comprises western Oklahoma, western Texas to the southern boundary of New Mexico and eastern New Mexico.

SPECIES RECOMMENDED.

The trees adapted to these sections are presented in two groups in the approximate order of their desirability—those which are actually known to be hardy and those which are semihardy in certain districts or entirely hardy under irrigation. Of course it is not possible thus arbitrarily to divide the region by definite lines, as the range of any desirable tree overlaps from one section to the other.

HARDY TREES.

A list of hardwoods and conifers follows:

Northern Great Plains. (Western North and South Dakota, eastern Montana, and Wyoming.)	Central Great Plains. (Western Nebraska and Kansas, eastern Colorado.)	Southern Great Plains. (Western Oklahoma and Texas, eastern New Mexico.)
Hardwoods:	Hardwoods:	Hardwoods:
Green ash.	American elm.	Russian mulberry.
Box elder.	Honey locust.	American elm.
American elm.	Hackberry.	Honey locust.
Northwest poplar.	Green ash.	Green ash.
Caragana (Siberian pea).	Russian olive.	Russian olive.
Russian olive.	Cottonwood (common and lance-leaf).	Cottonwood.
Buffalo berry.	Poplar (Norway and Carolina).	Osage orange.
Chokecherry.	Chinese elm.	Hackberry.
Wild plum.	Buffalo berry.	Black walnut.
Conifers:	Willows (laurel-leaf, Russian golden, white).	Caragana.
Black Hills spruce.	Box elder.	Chinese elm.
Jack pine.	Osage orange.	Soapberry.
Colorado blue spruce.	Russian mulberry.	Conifers:
Red cedar.	Chokecherry.	Chinese aborvitæ.
Western yellow pine (bull pine).	Wild plum.	Red cedar.
Scotch pine.	Caragana.	Scotch pine.
	Black walnut.	
	Conifers:	
	Jack pine.	
	Western yellow pine.	
	Scotch pine.	
	Black Hills spruce.	
	Red cedar.	
	Chinese arborvitæ.	
	Colorado blue spruce.	

A further grouping of the hardy trees shows the uses to which they are best adapted. Most of the species listed are suitable for windbreaks, but many of them will not produce poles or lumber. The ideal shelter belt will contain a mixture of species, with the low-branching, compact species on the windward side and the larger and usually longer-lived trees on the lee.

The low-branching, compact species most suitable for windbreaks are Caragana (Siberian pea tree), Russian olive, buffalo berry, Russian mulberry, wild plum, and chokecherry. Most of the conifers listed, and particularly red cedar, Black Hills spruce, and Chinese arborvitæ, make very effective windbreaks.

For posts and small telephone poles, green ash, American elm, honey locust, osage orange, red cedar, jack pine, Scotch pine, and western yellow pine are suggested, but when used for these purposes, a preservative treatment with creosote is advisable for all these species except osage orange and red cedar.

Any of the species can be used for fuel. Box elder is usually of such poor form that it is not suitable for any other purpose.

Of the species adapted to the Great Plains, cottonwood, American elm, western yellow pine, and Scotch pine will make the best lumber.

SEMIHARDY TREES.

In the Great Plains region there are many trees that are hardy in certain sections but are of no value in others. There are also trees that are hardy on the eastern edge of the region that have been planted but little, if any, in the more severe regions farther west. These are listed in the following paragraph, and it would be well to try them out, at least in towns where plenty of water is available or on irrigated projects.

In the northern Great Plains (North Dakota, Montana, and northern South Dakota), linden or basswood, black walnut, Chinese elm, lance-leaf cottonwood, and Tartarian maple; in southern South Dakota, honey locust, hackberry, Russian mulberry, white willow, Russian golden willow, laurel-leaf willow, and soft maple. In the central Great Plains, the foregoing willows, osage orange, soft maple, Kentucky coffee tree, catalpa, sycamore, and white ash. In the southern Great Plains, catalpa, sycamore, ailanthus, Arizona ash, Arizona cypress, and New Mexico locust.

TREE DESCRIPTIONS.

A description of the more important species follows:

HARDWOODS.

Green ash (*Fraxinus lanceolata* Borkh.).—The green ash is found over practically the entire Great Plains, growing naturally on upper levels of the valleys and often pushing far up open valleys or ravines to the prairie levels. It grows very well under cultivation and is one of the most desirable trees for either shelter belts or woodlots. (Fig. 4.) It responds well to good treatment; in fact its value as a producer of useful material is largely dependent upon the care given it. In sections where it is attacked by a borer, it should be grown in mixture with some other species. It grows well on nearly all kinds of soil except sand and gravel and those soils that are heavily alkaline. In valleys, under most favorable conditions, it may grow an inch in diameter in two years; but in neglected upland groves it sometimes requires nine years to make that much growth. In plantations at North Platte, Nebr., green ash has attained an average height of 20 feet in 15 years.

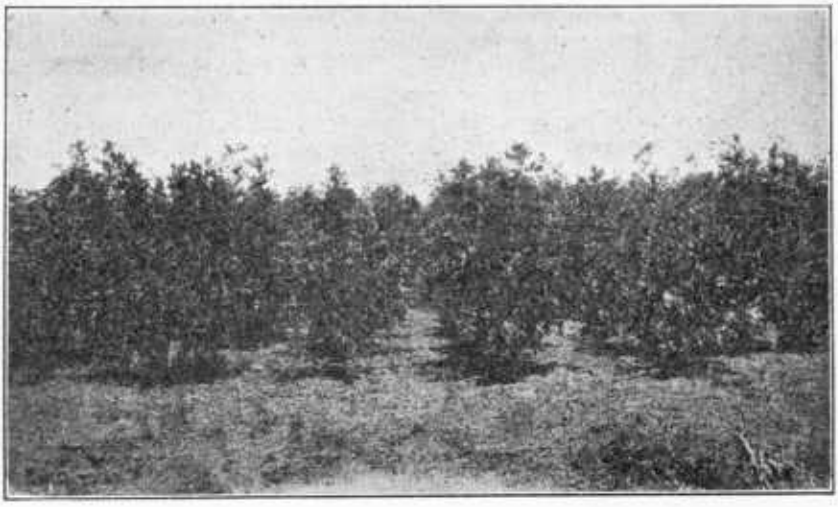

FIG. 4.—Green ash plantation 4 years old. Ardmore, S. Dak.

American or white elm (*Ulmus americana* L.).—The American elm is native to the Great Plains except in central Montana, Wyoming, Colorado, New Mexico, and western Texas. (Fig. 5.) It is, however, hardy to the foothills of the Rocky Mountains and is one of the best trees for shelter belts, woodlots, and street plantings on either upland or bottom sites, on dry or irrigated land. American elm thrives best in a heavy soil, but adapts itself fairly well to a sandy loam. Owing to its early flowering and seeding habit, the flowers or seeds are frequently killed by late frosts, and this often makes it impossible for several years in succession to secure local seed on the Plains.

FIG. 5.—White elm plantation 9 years old. North Platte, Nebr.

Honey locust (*Gleditsia triacanthos* L.).—The honey locust ordinarily may be planted from southern South Dakota southward through the Great Plains, although on exposed situations in northern Nebraska it occasionally freezes back. It has made a good record as a hardy, rapid-growing, general-purpose tree and is recommended for planting in that region. (Fig. 6.) It has rather light, open foliage and in shelter-belt plantings should be mixed with more densely foliaged trees. A large proportion of the trees have good form, and they are strong in stem and branch and not often injured by wind or ice storms. The tree is well adapted to heavy soils on uplands as well as on bottom lands and irrigated sections. Its rate of growth is only moderate, but is maintained for many years. Honey locust planted on an upland situation in northwestern Kansas has reached a diameter of 5.7 inches and a height of 24 feet in 20 years.

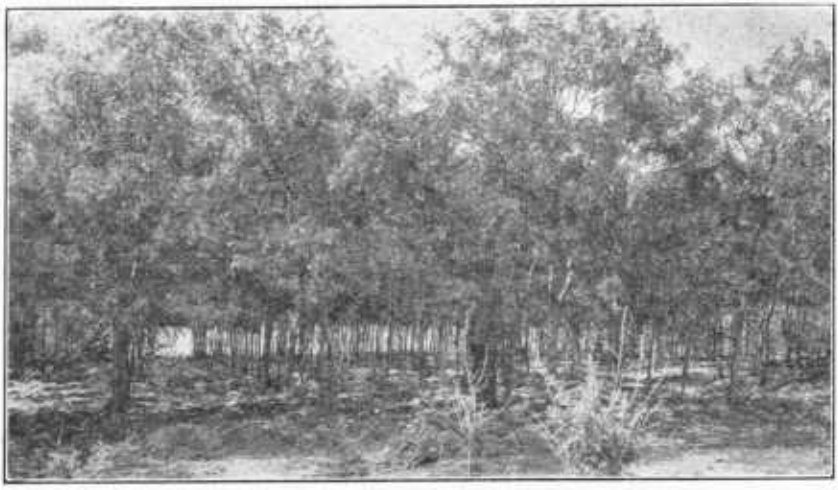

FIG. 6.—Honey locust plantation 9 years old. North Platte, Nebr.

Russian mulberry (*Morus alba tatarica* Loud.).—This mulberry has proved to be of greater value than the native varieties of the more central and southern States. On upland sites it has proved to be hardy as far north as southern South Dakota and to make excellent growth as a hedgerow or windbreak. Since this tree is somewhat variable as to hardiness, only proved hardy planting stock, preferably from locations north of those where the planting is to be made, should be used. Mulberry hedges and shelter belts are common in the central and southern Great Plains. (Fig. 7.) The tree is particularly desirable for planting around an orchard, as the birds will not bother fruit trees if they can feed on mulberries. The leading shoots frequently winterkill for a foot or two, and this increases the natural tendency of the tree toward a low, bushy growth. It branches diffusely near the ground, and only severe pruning can make it develop a respectable trunk. When well developed it makes good fence posts. An 18-year-old Russian mulberry hedge in southwestern Kansas will yield nearly 200 posts from a section 400 feet long.

FIG. 7.—Russian mulberry windbreak 6 years old. Woodward, Woodward County, Okla.

Hackberry (*Celtis occidentalis* L.).—The range of the hackberry includes the eastern Dakotas, and extends through Nebraska to Colorado, and southeast to the Panhandle of Texas. It has not proved entirely hardy in the northern Plains and is not recommended for plantings there. In general appearance it resembles the elm and would serve the same purpose in shelter belt, woodlot, or town plantings. It may be planted on both sandy and heavy soils and also on bottom lands. Grown in combination with American elm at the North Platte (Nebr.) Experiment Station it equals the elm in height at the end of 16 years.

Box elder (*Acer negundo* L.).—This tree, also called ash-leaved maple and Manitoba maple, is without doubt the hardiest of the maples, growing in valleys to the Rocky Mountains. Because of its low-branching habit it is planted in great quantities throughout the northern and central plains for shelter-belt purposes. (Fig. 8.) It

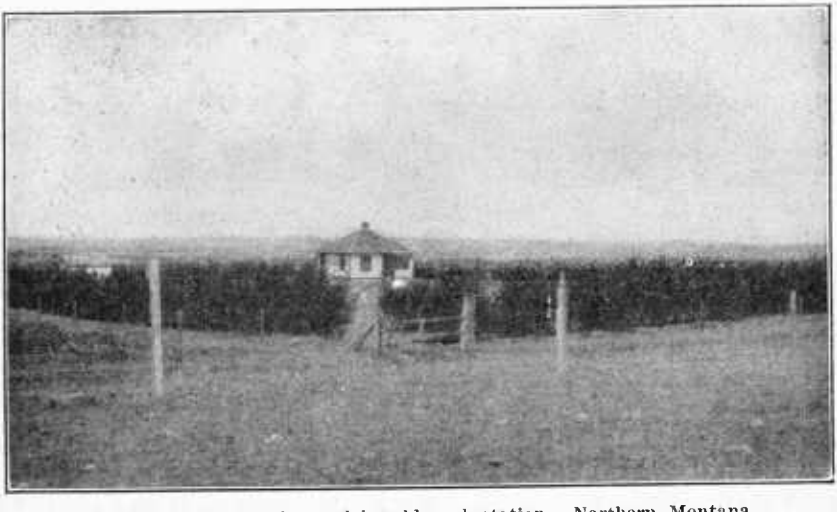

FIG. 8.—Norway poplar and boxelder plantation. Northern Montana.

is one of the best trees for such upland plantings, but is liable to suffer some slight injury the first winter or two after it is set out. After becoming acclimated it makes good growth. It is not to be considered as a first-class woodlot tree, although a 27-year-old plantation at Great Bend, Kans., has attained an average diameter of 7 inches and a height of 25 feet.

Caragana (*Caragana arborescens* L.).—This shrub, often called Siberian pea tree, makes its best growth in the northern Plains on more or less heavy upland soils. It does not do well in sand or

FIG. 9.—Cottonwood plantation 24 years old. Buffalo County, Nebr.

gravel or in low, wet situations. No attempt should be made to train it into a tree, as its natural form is shrubby. It is ideal for hedges and as low-growing trees on the outside of shelter belts. It is also used for group plantings about buildings or on lawns. In some sections of the northern Plains it is severely attacked by blister beetles.

Russian olive (*Elæagnus angustifolia* L.).—The Russian olive is one of the best trees to plant for shelter-belt purposes throughout the Great Plains. It is thorny and usually bushy, although in some favorable locations it grows as high as 40 feet. When planted fairly close the trees will keep out live stock. It does well in dry land and

in irrigated sections on both upland and bottom land, except in low, wet situations. It is not a woodlot tree. Its unique silver-green foliage adds wonderfully to the appearance of any combination in which it is planted.

Cottonwoods and poplars (*Populus* spp.)—Cottonwoods and poplars are fast-growing trees and are common over the entire region, though of several species and nursery varieties. (Fig. 9.) Where quick results are wanted, they are good trees to plant, provided the proper species or varieties are used. They make excellent additions to shelter belts and serve many purposes in woodlot plantings.

In the northern Plains the northwest poplar is the best to plant. (Fig. 10.) It is native to North Dakota, seems adapted to all kinds of soils, and, if well cultivated, has proved able to endure both the winter cold and the summer drought even on upland soils.

The common cottonwood will not always succeed in upland planting, but with cultivation some excellent plantations have been raised

FIG. 10.—Northwest poplar. Wells County, N. Dak.

on uplands. In general, it is not recommended for dry situations. On sites favored with moisture, even at a considerable depth, it will make good growth. It has been extensively planted throughout the northern and central Plains, particularly on tree claims, and considerably in the southern Plains and the eastern parts of the northern Plains. (Fig. 11.) However, it does not do well on the uplands of the northern Plains west of the Missouri River. The nursery varieties, Norway poplar and Carolina poplar, are entirely hardy in southern South Dakota and in Nebraska. Cottonwood is short-lived, but on account of its rapid growth quickly furnishes fuel and shelter, and for these purposes it has been almost indispensable to many settlers. On sandy loam soil in southwestern Kansas, cottonwood has attained in 28 years a diameter of 18 inches at 4 feet from the ground and a height of 70 feet.

The lance-leaf cottonwood of the eastern Rocky Mountain slope is also a desirable tree for the western part of the northern and central

Plains. "Canadian poplar" is one of the Russian poplars which has been extensively planted in the northern Great Plains. It is hardy to winter cold and resists the ordinary amount of drought, but is subject to attacks by canker, a disease which soon girdles the tree, generally near the base or at a crotch, and kills that portion above the canker. This disease is quite common on all Russian poplars grown in this region. For that reason they are not recommended for general planting.

Buffalo berry (*Shepherdia argentea* Nutt.).—This low tree or shrub is native to the Great Plains, except Oklahoma and western Texas. It is very hardy and naturally grows in very difficult situations. It responds readily to cultivation and, except on low, wet situations, is recommended for windbreaks when cultivation can be given. It may grow to be 20 feet high under favorable conditions. Where little or no other native fruit is obtainable, the currantlike berries are eargerly sought for household purposes.

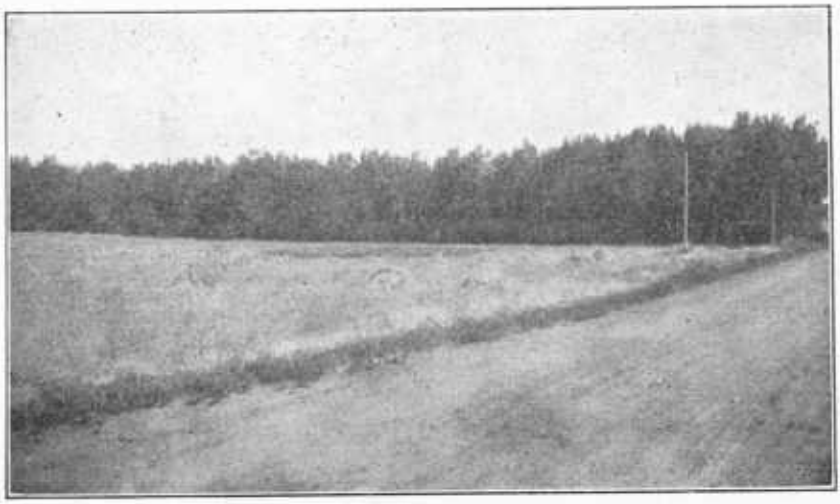

FIG. 11.—Cottonwood timber claim. Trees 35 years old. Steele County, N. Dak.

Osage orange (*Toxylon pomiferum* Raf.).—Osage orange is a very desirable tree for parts of the central and all of the southern Plains for shelter belts, hedgerows, and woodlots. It winterkills in northwestern Nebraska and in eastern Colorado, except in the Arkansas Valley. It is one of the best trees for upland planting in western Kansas and will live even when crowded by the grasses. It is very hardy and resistant to various forms of tree diseases. It does not make so rapid growth nor become a tree of so good form as the honey locust, but it is unsurpassed for posts, poles, and fuel. A 17-year-old hedge of osage orange near Hays, Kans., averaged 25 feet high and 6.4 inches in diameter. Twenty trees taken consecutively in a row produced 22 stakes and 47 posts. Another hedge 30 years old in western Kansas, from which many posts had been cut, it was found upon examination, would still yield from a 500-yard section 1,000 posts, some of them 12 inches in diameter. These posts

are known to the lumber trade as "bois-d'arc," and are kept in stock by many lumber dealers in the southern Plains.

Chinese elm (*Ulmus pumila* L.).—The Chinese dry land elm, which was introduced by the Department of Agriculture in 1908, has grown well on heavy or light soils wherever tried, though apparently preferring the heavier soils. It is a fast-growing tree of dense foliage and inclined to low branching. It promises well for shelter-belt, woodlot, and lawn planting. A suspicion has arisen that there may be two forms or strains of this elm, one of which, coming from a different locality in China, is proving hardier than the other. In the northern Plains the trees of this species so far tried have not been entirely hardy, but under irrigation in South Dakota and in the central Plains without irrigation the species has proven very satisfactory.

Willows (*Salix* spp.).—The willows have not been found suitable for upland plantings in the northern Plains, though in the central Plains they have done fairly well, particularly on the banks of reservoirs. Their use is probably limited to the more moist situations. The common diamond willow has not proved very desirable when grown on upland, but it makes good growth along the bottoms. The laurel-leaf and Russian golden willows have been extensively tried out in the northern Plains and have often proved unable to endure either the cold of winter or the summer drought. They are not generally recommended for upland planting north of southern South Dakota, except on the eastern limits of the Plains. The same recommendations can be made as to planting the white willow.

Chokecherry (*Prunus virginiana* L.).—The chokecherry grows naturally in the valleys and river bottoms over practically the entire Great Plains region. It has been tried in a few places on the uplands in the northern Plains and has proved well worth planting for shelter-belt purposes. Except that it is not well adapted to very sandy or to low, wet situations, it is not particular as to soil, but it needs good care. It produces suckers profusely, and this is sometimes an objection to its planting.

Wild plum (*Prunus americana* Marsh.).—The wild plum is native over the Great Plains. Where planted as seedlings in shelter belts or woodlots it makes good growth and often produces fruit in five years. While it has not been generally planted, it is well worth trying out.

Catalpa (*Catalpa speciosa* Warder).—Catalpa will thrive under the proper conditions in western Kansas, Oklahoma, and Texas. It is not well adapted to the most rigorous sites, but it has been raised successfully on sandy loam soils where there is permanent water at a depth of 10 to 20 feet. It has been recommended by the Woodward Field Station in Oklahoma for low, wet bottoms where extensive drainage will be necessary before crops can be raised. (Fig. 12.) On such land, unless the soil is alkaline, catalpa will make a rapid growth and produce an abundance of posts. There are records of catalpa plantations in central and western Kansas that have produced 3,000 posts per acre and better in 14 to 18 years.

Black walnut (*Juglans nigra* L.).—Black walnut has been planted in different sections of the Plains as far north as Mandan, N. Dak.

Although it has proved hardy under severe conditions, it has thrived only under favorable conditions. There is a tendency for the trees to die out gradually in upland plantations. Black walnut winterkills in most parts of eastern Colorado, except in towns and cities and within 30 miles of the foothills. Only by planting on protected

FIG. 12.—Hardy catalpa plantation on low ground. Woodward County, Okla.

sites, preferably in valleys, by careful cultivation, and by the use of seed from hardy trees can black walnut be adapted to most parts of the Great Plains. Although this species offers possibilities for planting under favorable conditions in the central and southern Plains, it can not be recommended as a tree for general planting. It

should be planted in more or less open groves or woodlots. In southern South Dakota it has borne nuts after 8 or 9 years.

Soapberry (*Sapindus drummondii*).—Drummond's soapberry occurs naturally in river valleys and on hillsides, often on moist unfavorable sites, from southern Missouri through Oklahoma and into New Mexico. It appears to be free from injurious insects. It is not a rapid-growing tree, but often reaches a height of about 40 feet. This tree has been only occasionally planted in the southern Plains, but it is believed to be very hardy, and should make a good tree for that region. It has been successfully planted as an ornamental tree at Woodward, Okla., and at other towns in the southern Plains.

Silver or *soft maple* (*Acer saccharinum* L.).—Silver or soft maple has been extensively used in the central Plains principally for ornamental and windbreak planting. It matures at an early age, the wood is decidedly brittle, and large branches are often broken off in heavy windstorms. As silver maple is not very drought-resistant, it can be recommended only for valley planting where the roots will eventually go down to water. In such places it will quickly furnish shade and shelter.

CONIFERS.

Fewer conifers or evergreens than hardwood species are adapted to the Plains. None of these will withstand alkaline soils. They require more care, and the loss may be heavier; but those that are adapted to the region make more permanent and effective windbreaks than the hardwoods. It is best to prepare for conifers by setting out a belt of hardwoods of some of the species just discussed. After these hardwoods are several years old and are making good growth, the conifers should be set out in a belt on the leeward side and about 20 feet from them. The conifers will then not be subjected to the root competition of the hardwoods; they will receive protection from the prevailing winds; and they will be covered during the winter by the snow that drifts in to the leeward of the hardwoods.

Jack pine (*Pinus divaricata* DuMont de Cours).—A native of the Lake States, jack pine has proved very adaptable to the sandy and light loam soils of the northern and central Great Plains. It does not thrive on heavy clay soils or in low, wet situations. It does well planted either as a shelter belt or woodlot and is recommended for general planting. It is a very rapid-growing conifer, averaging under favorable conditions a foot a year for 40 years. Jack pine has been planted extensively, particularly by the Forest Service, in the Nebraska sandhills, where it adapts itself very readily to the conditions and makes rapid growth. Trees that have been planted 19 years now average 25 to 30 feet in height and are large enough for posts. A grove of jack pine planted 2 feet apart on a sandhill in Holt County, Nebr., in 1891, produced in 28 years approximately 36 cords of 4-foot wood per acre. Although the trees were planted so densely that they retarded each other's development, trees large enough to produce 742 fence posts and 58 small telephone poles per acre had developed. (Fig. 13.)

Western yellow pine (*Pinus ponderosa* Laws).—The western yellow or bull pine is native to the southeastern part of Montana and western North Dakota and south through the Black Hills to northern Nebraska and eastern Wyoming, Colorado, and New Mexico. Although it has been comparatively difficult by planting to obtain suitable stands of this tree in sections of Montana, North Dakota, and South Dakota, it has done very well in Nebraska and Colorado. It grows more slowly than either the jack or Scotch pines, but, once established, is very hardy. This tree has been extensively planted in the Nebraska sand hills by the Forest Service, where, after becoming thoroughly established, it has made an excellent growth, although handicapped to some extent by an insect, the pine-tip moth.

FIG. 13.—Jack pine plantation 30 years old. Holt County, Nebr.

A western yellow-pine plantation established in 1888 in Rock County, Nebr., with 3-year-old forest-pulled seedlings spaced 11 feet apart, showed after 31 years a total volume of 2,339 cubic feet, or approximately 30 cords of 4-foot wood per acre. The average diameter 4½ feet above the ground was 10.1 inches, and the average maximum height was 45 feet. There were 113 trees per acre averaging 11.6 inches in diameter and capable of producing two railroad ties each. (Fig. 14.)

Scotch pine (*Pinus sylvestris* L.).—The Scotch pine is a very hardy tree and should make good growth in both shelter-belt and woodlot plantings. It does not make as rapid growth at the start as jack pine, but passes it within 10 years. It may be planted with a fair likelihood of success in most parts of the Great Plains region, except, perhaps, on low, wet situations. It is preferable to plant

only the Riga or northern Europe variety, because of its more rapid growth and better form. (Fig. 15.)

Chinese arborvitæ (*Thuya orientalis* L.).—The Chinese arborvitæ is recommended for general shelter and lawn planting for Kansas and southward, and for irrigated sections in Nebraska. Unlike the

FIG. 14.—Western yellow-pine plantation. Trees 10 inches in diameter. Rock County, Nebr.

American arborvitæ, it thrives on heavy upland or limestone soils. It is not a large tree, but its small size is more than compensated for by its hardiness and luxuriant growth. As it is an introduced tree from China, little is known concerning its behavior in old age. This tree is not considered suitable for woodlot plantings.

Cedars (*Juniperus virginiana* L. and *Juniperus scopulorum* Sarg.).—The red cedars, both eastern and western varieties, are well worth planting over the entire Great Plains. They are hardy under severe conditions and are comparatively easy to transplant from their

FIG. 15.—Scotch pine 6 years old. Woodward, Woodward County, Okla.

native sites. They form a very effective shelter belt both winter and summer. Some objections are raised to the cedars because of the presence of the "cedar-apple" fungus, a disease which also affects apple trees in the immediate vicinity. As orchards in the

high plains are very scarce and not likely to be common for some years, this objection is not a serious one. According to Prof. B. O. Longyear, of the Colorado Agricultural College, the disease coming from cedar apples on *J. scopulorum* does less harm to fruit trees than when it is transmitted from *J. virginiana.* Scopulorum is the handsomer tree in Colorado and is called " silver cedar " by nurserymen.

Black Hills spruce (*Picea canadensis* B. S. P.).—The Black Hills variety of the white spruce is recommended for general shelter-belt planting in the northern Great Plains and in Nebraska. It makes a fairly rapid growth and is extremely hardy.

Colorado blue spruce (*Picea parryana* Sarg.).—The Colorado blue spruce is native to parts of Wyoming, Colorado, Utah, and New Mexico. When planted on dry-land sites in the northern and central Great Plains, it has generally proved satisfactory. It grows best on the clay soils. It makes slower growth than the Black Hills spruce, but is hardy.

In addition to the above conifers, limber pine (*Pinus flexilis* James) has been successfully planted in several places in eastern Colorado and pinyon pine (*Pinus edulis* Engelm.) in the panhandle of Oklahoma and Texas and in eastern New Mexico.

MIXED PLANTATIONS.

Most of the older plantations in the Great Plains have been made with but a single species. For shelter and woodlot planting, it is sometimes preferable to plant two or more kinds of trees in mixture. Species that have scant foliage may well be combined with those having denser crowns, so as to provide a heavier shade which will kill out the grass and weeds. It may be advisable to plant a long-lived species with one which comes to early maturity. A mixture gives some assurance of a stand of trees even if one of the species is killed or seriously injured by insects or disease.

Tentative conclusions from experimental plots of mixed species indicate that the following combinations should prove successful on soils and in regions adapted to both species:

Boxelder and green ash.
Green ash and American elm.
Northwest poplar and boxelder.
Green ash and honey locust.
Cottonwood or northwest poplar and green ash.
Cottonwood or northwest poplar and silver maple.
Honey locust and hackberry.
American elm and hackberry.

These combinations will do better if the outer rows are planted to Caragana or Russian olive. The dense screen that these species form assists in keeping out the wind, the light, and an encroaching growth of grass.

ORNAMENTAL PLANTING.

Many of the more desirable hardwoods of the Mississippi Valley have been acclimated for planting as lawn, park, and street trees in the towns of the Great Plains region. In towns the trees have more protection from the drying winds, and it is possible to furnish them

the needed water. Some towns now prohibit the planting of box-elder, black locust, and female cottonwoods, and recommend such trees as American elm, honey locust, hackberry, bur oak, black walnut, and American linden. Red oak and pin oak grow successfully in the city of Denver. Conditions vary so much throughout the range of the Great Plains that it is advisable to ask the advice of the nearest State or Government agricultural experiment station before planting any species which has not already been tried in the vicinity and proved hardy.

FIG. 16.—*Spiræa vanhouttei.* Woodward, Okla.

Many shrubs have been found hardy for the Great Plains. (Fig. 16.) By planting them in groups around the farmhouse, in corners of the yard, and as screens to conceal outbuildings, the farm home will not only be a more desirable place in which to live, but the value of the farm will be greatly increased.[2]

The following shrubs have been found hardy and drought-resistant for the northern and central Great Plains:

[2] See U. S. Department of Agriculture Farmers' Bulletin No. 1087, "Beautifying the Farmstead."

Missouri flowering currant (*Ribes aureum*).
Dogwood (*Cornus stolonifera* and *C. sibirica*).
Common lilac (*Syringa vulgaris*).
Himalayan lilac (*Syringa villosa*).
Persian lilac (*Syringa persica*).
Spirea (*Spiræa arguta, S. vanhouttei*, and *S. sorbifolia*).
High-bush cranberry (*Viburnum opulus americana*).
Snowball (*Viburnum opulus sterilis*).
Tartarian honeysuckle (*Lonicera tatarica* and *L. morrowii*).

The flowering currant and dogwood occur naturally in many parts of this region and are especially desirable for ornamental plantings. Buffalo berry, Russian olive, and Caragana, previously listed as shelter-belt trees, have also been found valuable for hedges and ornamental planting.

The following list of hardy shrubs is recommended for the southern Plains:

FIG. 17.—Tamarisk hedge 3 years old. Woodward, Woodward County, Okla.

Rough-leaved cornel (*Cornus asperifolia*).
Japanese quince (*Cydonia japonica*).
Chickasaw plum (*Prunus augustifolia*).
Smooth sumac (*Rhus glabra*).
Missouri flowering currant (*Ribes aureum*).
Plum-leaved spirea (*Spiræa prunifolia*).
Coralberry or Indian currant (*Symphoricarpos vulgaris*).
Persian and common lilac (*Syringa persica* and *S. vulgaris*).
Early-flowering tamarix (*Tamarix parviflora*).
Van Houtte's spirea (*Spiræa vanhouttei*).

The tamarix, in addition to having ornamental value as a shrub, is being satisfactorily used as a hedge and windbreak. (Fig. 17.) Many other shrubs have been found hardy for planting on the Great Plains, but the foregoing lists can be depended upon.[3]

[3] Acknowledgment is due to T. K. Killand, assistant horticulturist of the Northern Great Plains Field Station, Mandan, N. Dak., for the list of shrubs adapted to the northern portion of the Great Plains, and to Christian Jensen, superintendent of grounds and landscape designer of the Oklahoma Agricultural and Mechanical College, Stillwater, Okla., for the list of shrubs for the southern half of the Plains.

LOCATION OF THE PLANTATION.

The shelter belt should be planted on the side of the farm buildings from which the prevailing winds come, which for most of the region means either the northwest or the southwest. It should be long enough to protect the buildings, orchard, and possibly the feed yards, and to be thoroughly effective should be not less than 40 feet wide. It should not be closer than 100 feet to the principal buildings, and it might be well to leave a greater distance, so that there will be ample room for new buildings or for planting more trees. If the trees are planted too close to the buildings, snow is apt to sift through the windbreak and form drifts near buildings. If the windbreak is made up of a belt of hardwoods and then another belt of conifers about 20 feet distant on the sheltered side, the space between them will serve as a snow trap.

The woodlot should be located wherever convenient; but, if it is placed along the west boundary of the farm, it may serve also as a windbreak to an orchard or field.

CHOICE OF PLANTING STOCK.

A plantation established with poor stock is handicapped. Good stock should be chosen. One-year-old or two-year-old hardwood seedlings give best results under normal conditions. Older stock should be avoided. It is more expensive and requires more time and attention to plant. If, however, conifers are planted, nothing smaller than 3-year-old transplants should be used. Transplants are preferred because their more fibrous root systems make them better able to absorb available moisture and accommodate themselves to their new site.

SOURCE OF PLANTING STOCK.

Hardwood seedlings may be purchased or readily grown from seed in the home garden. By collecting seed from trees which occur naturally in the region the planter will be certain of securing seedlings which are true to name and adapted to local conditions.

American elm and silver or soft maple seeds should be sown as soon as they are ripe, which is in May or June. Caragana seeds should be picked in July before they are entirely ripe on account of a habit which the pods have of splitting open when dry and throwing the seeds out. These seeds sprout readily. They may be sown as soon as picked or in the following fall, or they may be stratified and sown the next spring. If the seeds are sown as soon as gathered, the plants will make considerable growth the same summer and will be ready for transplanting to their permanent site at the end of the following summer. Seeds of green ash, boxelder, honey locust, and Russian olive should be collected in the fall, stratified in moist sand over winter, and sown the following spring.

The seeds should be sown in rows, in much the same manner as vegetable seeds. The plants should be watered and cultivated so they will become as large as possible in one growing season. After the middle of August, only enough water should be applied to keep the ground from drying out completely in order to harden the tender wood and thus prevent damage to the plants from early frosts.

Cottonwoods and willows are generally propagated by means of cuttings. These cuttings, which are best made in the fall or early winter, should be from 7 to 10 inches in length and taken from 1-year-old or 2-year-old twigs of healthy trees. Cuttings should always be made with a sharp knife to avoid bruising the bark. If trees free from seed or "bloom" are desired, cuttings should be taken from trees which observation has shown do not produce seed. Cuttings should be buried in cool, moist, well-drained sand until spring. Best results will then be secured by setting them in the garden for a year. Here, where they can be given care, they will take root, and the following spring they may be set out on the permanent site as 1-year rooted cuttings. Unrooted cuttings, however, will often grow if set out directly on well-tilled irrigated land or in subirrigated river bottoms.

Conifers are much more difficult to raise from seed than are hardwoods, and, unless a large project is undertaken, it is inadvisable to attempt to grow them at home. Thrifty stock may be purchased from reliable nurserymen, and sometimes at cost from nurseries maintained by the States. Stock grown as near as possible to the region of planting is always preferable to that grown in more southern districts.

PREPARATION OF SOIL.

Before the planting, the soil must be thoroughly worked up and the sod completely rotted. On new ground it is usually desirable to do the breaking at least two years before planting the trees. During the season following the breaking, the land should be disked, harrowed, or cultivated as often as is necessary to keep the ground clear of weeds, grass, or other vegetation. Clean summer fallow of this type is the best method of preparing land for the planting of trees.

On certain portions of the Plains region where the soil is a sandy loam, the sod not so heavy, and there is danger of the soil's being blown, plowing 12 months previous to planting is sufficient. To prevent winter blowing, such areas should be ridged in the fall by being gone over with an ordinary cultivator or lister.

Better results are usually secured on ground which has been under cultivation for several years. The land should not be cropped to grain, alfalfa, or sweet clover the summer previous to planting, as these crops will use the moisture that should be stored up for the trees.

TIME OF PLANTING.

Throughout the entire Plains region the best results are secured from early spring planting. This gives trees the advantage of an entire growing season in which to become established before they are subjected to the rigors of winter. They also have the advantage of the accumulated winter moisture, and the liability of loss from winter heaving caused by alternate freezing and thawing is slight. Fall planting may sometimes be successful if it is possible to give each tree individual attention, but for general planting it usually results in failure and is not recommended. It is a decided advantage if the planting can be done on damp, cloudy days. Hot, windy days should be avoided for tree-planting operations.

METHODS OF PLANTING.

Planting methods are largely determined by the size of the stock and the condition of the site. Regardless of the method followed, however, certain rules should be observed. When trees are purchased, the package upon arrival should be opened in a barn or shed and the roots well moistened. They should not be exposed to the sun or drying wind. If the roots of each tree are bound with earth and burlap, the burlap need not be removed and the whole bundle should be planted. If the weather permits, the trees should be planted immediately. This insures best results. If that is not possible, they should be "heeled in" in a sheltered location. A trench is dug 8 to 12 inches deep, with one sloping side, against which the trees are placed in thin layers with the roots extending downward. The roots are then well covered with moist soil. Trees may be kept in this way for some time, although warm weather may start their growth. Trees grown at home should not, of course, be dug up until they are to be planted.

In planting, great precautions are necessary to keep the roots of the trees from drying out. They should be kept moist at all times. This is especially important in the case of conifers, for they are easily killed by the exposure and consequent drying out of the roots. On dry, windy days a few minutes' exposure is fatal. The trees may be wrapped in a wet piece of burlap or carried in a bucket, with the roots covered with moist dirt. A method successfully used in a number of places and especially desirable for conifers is that of filling a tank half full of very soft mud and placing the roots of the trees in this. The tank is hauled around on a sled as the trees are planted. The film of mud on the roots keeps them from drying out so rapidly if they should be exposed.

If the soil is not very moist at the time the trees are planted, it is advisable to water them after they are set out wherever that is practicable. This would, of course, be a laborious task on most dry-land farms where water would have to be hauled.

FURROW PLANTING.

A furrow from 8 to 12 inches deep, depending on the length of the roots, should be plowed along a staked line. While the tree is held in an upright position with roots in the bottom of the furrow, the soil should be pulled in from both sides and tamped solidly around the roots, so that the tree will stand upright. The furrow is then filled with soil and leveled. The trees should be set about an inch deeper than they were in the nursery, and the soil should not be hilled up. Not more than one or two furrows should be opened at a time. If a furrow is left open too long the soil will become dry and the result will be disastrous to the trees.

INDIVIDUAL HOLES.

This method is best adapted for planting trees with large root systems or for use on heavy or rocky soil, although it must again be emphasized that the only certain way of getting results in the Plains region is to plant in thoroughly tilled soil. Steep hillsides which

can not be plowed can be planted by this method. A hole should be dug wide enough and deep enough to accommodate the tree roots without crowding. After the tree has been set in the hole with its roots extended, the soil should be pulled in over the roots and tamped thoroughly. Large rocks and sod should not be allowed to fall in around the roots because of the possibility of their causing air spaces, which would allow the roots to dry out. It is best to plant the tree immediately after digging the hole.

SLIT METHOD.

In the slit method a wedge-shaped hole is opened in the ground by inserting a spade and moving it backward and forward. Into this opening the tree roots are inserted full length, and the earth is pressed firmly around them by a thrust of the foot or by making another slit with the spade several inches beyond the tree and pressing the soil toward it. This method is adapted to light, sandy soils where, because of the danger of the soil's drifting, it is unwise to break up all of the sod, and to hillsides where complete plowing might result in erosion. In such sites, furrows may be plowed 6 or 8 feet apart and the trees planted in them. On hillsides the furrows should follow the contours.

NUT PLANTING.

Such trees as oaks and black walnut, which are grown from large nuts, are best propagated by planting the nuts where the trees are to grow, as the long taproots of such trees make successful transplanting from the nursery to the field quite difficult. A good method is to bury walnuts in a shallow pit over winter. When the nuts begin to sprout in the spring they should be planted in shallow holes in well-tilled land and covered lightly.

PLANTING CUTTINGS.

Early in the spring cuttings should be set out in well-tilled soil in a slanting position, with the buds pointing upward, and with about an inch of the cutting protruding above the ground. The cuttings may be set in a furrow or in holes made with a bar or dibble. After they are set, the soil should be pressed firmly about them.

SPACING.

For shelter belts it is desirable to have the trees far enough apart so that they can be cultivated from three to five years, but not so far apart that their value for wind protection will be minimized. Such close spacing as 4 by 4 feet, which has been tried out in certain localities, has not been found practicable in the Plains region in the United States. Trees planted as close as this are difficult to cultivate and are likely to be stunted. It is very doubtful whether the shade provided by closely spaced trees would conserve enough soil moisture to support them during those periods of drought extending over several years to which the region is liable.

As a result of extensive tests in the Plains region, a spacing of 8 by 6 feet or 8 by 8 feet is recommended for shelter-belt planting.

This will permit cultivation both ways for a period of two to five years. It will also provide for sufficient trees so that, if some should die, enough will ordinarily live to make any replanting unnecessary. Some loss is almost certain to occur in every plantation.

Species such as Caragana, buffalo berry, and Russian olive, which are often planted as 1-row or 2-row hedges or windbreaks, should be spaced 2 or 3 feet part in the row.

For woodlots a spacing of 8 by 6 feet is advocated, in order that trees with straight stems and few branches may be produced. If this proves to be too dense in those portions of the Plains having the least rainfall, the smaller trees may be cut out and used for posts or fuel.

On river bottoms or on subirrigated land trees may be spaced closer than on dry land. There a spacing of 6 by 6 feet is recommended for woodlots and 8 by 4 feet for shelter belts.

Some tree planters have advocated planting trees as far apart as 15 by 6 feet or even 24 by 6 feet, because available soil moisture is the controlling factor in tree growth, and ordinarily there is not sufficient moisture on the dry-land farms of the Great Plains to support a denser mature stand. Such wide spacing necessitates clean cultivation for many years, and, as farmers sometimes neglect this on account of the press of other work, their woodlots are soon overgrown with weeds and a heavy loss of trees follows. Many old timber claims, throughout the Plains, with their few struggling, misshapen trees contending against the vegetation, are examples of this. Experience has shown that it is better practice to space the trees more closely, so that cultivation may be discontinued after the fourth or fifth year, when the trees will have shaded out the grass.

CARE OF PLANTATIONS.

CULTIVATION.

A large proportion of failures in plantations is caused by the negligence of the planters. It is a mistake to suppose that trees will live and thrive if they are set out in a weedy or grassy area and then left to shift for themselves. The slow, scrubby growth of natural groves of trees in the Great Plains and the miserable appearance of neglected planted areas are excellent illustrations of the truth of this. Cultivation is just as necessary in establishing a successful plantation of trees as in other lines of agriculture, and the results are proportionate to the amount of labor expended in keeping the soil loose and free from weeds. Cultivation stimulates tree growth, and no other operation helps so much to lessen the losses caused by insufficient moisture.

The area should first be cultivated at least one year and preferably two years before the trees are planted. After planting, cultivation should be repeated as often as necessary to keep the weeds down and should be continued every season until the trees have grown too large for the work to be done between the rows. Cultivation should extend 5 or 10 feet beyond the limits of the plantation. This strip of cultivated soil will retard the encroachment of grass and weeds and also serve as a firebreak. Under no circumstances should the weeds be allowed to grow so high that a plow must be used to destroy them; weeds rob the trees of moisture, and a plow or any deep

cultivator may injure the fine tree roots. A one-horse cultivator can be used to best advantage if the trees are spaced as recommended.

The only other method that seems practicable in eliminating weeds from small plantings is to fence the area after the third or fourth season and use it for a chicken yard. The chickens will keep down the weeds and insects and scratch up the soil.

THINNING.

The object of thinning is to remove those trees which, because either of their unhealthy condition or crowded position, are retarding the growth of the more desirable individuals. Just as an overcrowded stand of vegetables is thinned by a gardener, so the poor trees in a woodlot should be cut out. The result is the best development of those remaining. The best-formed, most valuable, and most healthy trees should be selected to remain. Need of thinning is indicated if, on account of crowding, there are many dead or dying trees in the stand, or if the trees are very slender in proportion to their height.

Although thinnings will not ordinarily be necessary until the wood lot is 15 to 20 years old, on irrigated land they may be desirable earlier. Care should be exercised not to remove so much material that the sun will shine through and induce a growth of grass under the remaining trees. The openings in the tops should close in three or four years. The fact should not be overlooked that in a large grove the shade afforded by the crowns of the trees takes the place of cultivation in keeping the grass down and lessening the evaporation of water from the soil. The first thinning will yield fuel and small posts, and, if the poorer material is removed each time, each subsequent thinning will remove bigger and better material.

A shelter belt should ordinarily be thinned only if many of the trees are plainly in an unhealthy condition. Unless considerable care is exercised, the removal of trees from a shelter belt will lessen its protective value.

PRUNING.

Pruning of the branches of trees in a plantation is in general unnecessary and, because of the cost of labor involved, undesirable. Pruning in shelter belts is not at all advisable, as a dense growth not only gives the most protection to the farm buildings but also protects the trees themselves. The bushy growth protects the trunks of the trees from sun scald, prevents the growth of grass and weeds, and retards evaporation. Species like the Siberian pea tree, which do not develop a main stem but send out a dozen or more shoots, should not be pruned. In the Plains region the greatest value of conifers is in the protection which they afford against wind. As low branches make them more effective in this respect, they should ordinarily not be pruned.

If a young tree is frozen to the ground for a few years in succession it will send out a number of shoots from the base and make little growth in height. To stimulate growth, all of these shoots except one should be cut off close to the base. This shoot should

be allowed to become the leader, and, if shelter is the purpose of the planting, none of the branches it sends out should be pruned.

In woodlot plantations where it is desired to produce a good grade of material, it may sometimes be profitable to prune the best trees by cutting off such dead and brittle limbs as can be reached. Dead branches which persist on some hardwoods are likely to form loose knots and should be removed. If, because of wide spacing, the trees are assuming a poor timber form, it may be necessary to correct this condition by pruning.

Pruning may be done at any season, but fall or winter, when the tree is dormant, is the preferable time. It should not be overdone. If a tree is pruned too far up, it may become top-heavy and be easily broken off by a severe wind. Sharp tools should be used. Branches should be cut off close to the main trunk so that no stubs are left through which wood-rotting fungi may enter the tree.

PROTECTION.

AGAINST CATTLE AND RODENTS.

Grazing animals should never be allowed to use the plantation as a pasture. The animals almost invariably cause damage to the trees by nipping off the branches, peeling the bark, trampling the small trees, and packing the ground hard and dry, thus robbing the trees of much-needed moisture. Every plantation should be fenced with rabbit-proof woven-wire fence to keep out live stock and rabbits.

The jack rabbit is the worst animal pest with which the grower of trees in this region has to contend. It not only strips the bark from the older trees, but will also cut off seedlings at the ground or at snow line. It especially prefers elm and ash, but will cut off poplar, willow, and young jack pine branches when they extend above the snow. Rabbits like alfalfa better than trees, and, if a stack of alfalfa is near by, they will seldom bother the trees.

Rabbits may be poisoned by sprinkling a strychnine solution on alfalfa leaves. This is prepared by dissolving one ounce of strychnine sulphate in 2 gallons of hot water and sprinkling it over 10 pounds of alfalfa hay leaves. The leaves should be mixed thoroughly until all moisture is absorbed. Other methods of poisoning may be learned from the Bureau of Biological Survey, Washington, D. C., from State foresters, or from experiment stations listed on page 34 of this bulletin.

Rabbits may be trapped readily by the following method, which has been suggested by the Kansas State Agricultural College Experiment Station in its Circular No. 17:

> Sink a barrel or keg in the ground level with the surface. Fit the head slightly smaller than the top and allow it to swing freely on a rod or old broomstick. Pieces of apple or corn may be fastened on the outer edge of the cover, and when the rabbit attempts to get these, the lid slips in and he slides into the barrel, while the lid, which is slightly heavier on one side than the other, assumes its original position. The heavier side should rest against a heavy nail or bolt so that only the lighter side of the lid will drop. The whole thing should be covered over with brush.

In many parts of the Great Plains, pocket gophers cut off the roots of young trees. These rodents may be poisoned by sprinkling a mixture of strychnine and saccharine upon cubes of sweet potatoes or

carrots, which are then inserted into the underground runways. Trapping is the surest method of exterminating pocket gophers, and several good traps for this purpose are on the market.

AGAINST INSECTS.

Various species of trees are attacked by insects in different parts of the Plains region. Poplar beetles and their black larvæ eat willow and poplar leaves. These beetles suggest the Colorado potato beetle in shape, but they are somewhat smaller and are black in color tinged with blue and more or less striped or spotted with yellow or orange. They appear when the leaves begin to come out in the spring and are at their worst during the month of June. Four to five broods may be produced before fall. Their attack is followed by disastrous results to the foliage and later by the death of the trees. Spraying with lead arsenate, prepared as directed on the containers, will destroy the insects. The spraying will yield most satisfactory results when the leaves are about half grown. The reappearance of the beetles in great numbers may necessitate a repetition of the treatment during the season.

The large, green, wormlike larvæ of certain moths are very destructive to the foliage of poplars and boxelders. One large worm may eat all the leaves on a young tree in a short time. A thorough spraying with lead arsenate should control this pest. Hand picking is also often resorted to.

Blister beetles are found on the young shoots of the Caragana in the month of June. They are of three kinds, the gray and the black (about three-fourths of an inch to 1 inch long), and the metallic blue (1 to 2 inches long). Spraying with lead arsenates does not seem to kill them, but drives them to other plants. They do, however, eat leaves sprayed with Paris green and are killed. The Paris green, however, does not adhere so well to the leaves and is generally more expensive. The Caragana does not seem to suffer much from these beetles unless entirely denuded. This denuding frequently weakens the trees to such an extent that they die within a year or so or leads to further and more severe attack each following year until death results. When only the ends of the young growth are eaten, the trees will often put out new leaves later in the summer. Blister beetles also attack green ash, Russian olive, and hackberry, sometimes doing considerable injury to young plantations.

The pine-tip moth (*Evetria bushnelli*) causes some damage to pine trees planted in western Nebraska by boring into the young shoots and hollowing them out for a distance of several inches. This distorts the growth of the tree if the leader is attacked several years in succession. There is no practical remedy for the control of this pest.

Black locust is well adapted to the southern part of the Plains, but its planting can hardly be generally recommended because of the damage done by the locust borer. Success has been attained in planting black locust in the low, wet bottom lands of rivers in western Texas and Oklahoma. The absence of the borers here has been ascribed to planting the trees so densely that the trunks are shaded. The shade, together with the rapid growth on the bottoms, seems to make the locust almost safe from attack. Green ash has also been severely injured in portions of the Plains by a borer, but in most

places this insect appears to be held in check by nature. The cottonwood borer causes some damage, but for the most part it is controlled by natural enemies.

Insects may cause serious damage. If an insect attack is severe, aid should be sought from the Bureau of Entomology, Department of Agriculture, Washington, D. C., or from the State experiment stations.

AGAINST FIRES.

In places where there are few cultivated farms and there is danger from prairie fires, a fire line 5 to 10 feet wide should be plowed around the plantation. If it is placed next to the outer rows of trees and kept clean, the growth of the exterior trees will be greatly stimulated. In sections where there is danger of the soil's being blown, the fire line should not be placed adjacent to the trees; for, if the soil is blown, small trees may be buried or the roots of larger ones may be uncovered.

WINTER INJURY.

Trees are more or less subject to winter injury throughout the Plains region. The causes of this are briefly as follows:

Trees that are not hardy to the section wherein they are planted are subject to freezing in the fall and winter. This is generally due to the inability of the plant to stand the severe winter, or to failure to ripen the year's growth of wood in the fall because of the shorter growing season of the region.

Other trees are subject to sun scald on the trunks and branches during winter and early spring. This causes the tissue on the south side to die and leaves a scar that forms a ready entrance for diseases.

Even hardy trees often dry out in the winter or spring during prolonged periods of drought. These usually recover and resume their natural growth unless killed to the ground.

Trees are often tender the first few years after planting, but later become acclimated and are thereafter hardy.

RESULTS.

There are very few plantations more than 15 years old in the Great Plains, in the development of which the principles of good tree planting, such as the proper selection of species and careful methods of planting and cultivation, have been followed. Hence there are few available figures showing the growth and the products that may be obtained. A large number of tree claims were established between 1878 and 1891 under the timber-culture act; but some of these plantations have been damaged by prairie fires, some have been ravaged by insects, some have been cut out or have died out, and on the whole they have been sadly neglected. (Fig. 18.)

Such data as are available indicate that despite scant rainfall, drying winds, and extremes of heat and cold, valuable wood products can be obtained from planting in the Plains region. Some of the hardiest species are either of poor quality or of poor form for posts or other timber products. Their value lies in their ability to grow at all or in their low-branching, compact habit, which is so necessary for making shelter and which is of more importance in the Great

Plains region than the production of clear timbers. It is well to remember, however, that even nondurable fence-post woods, which the

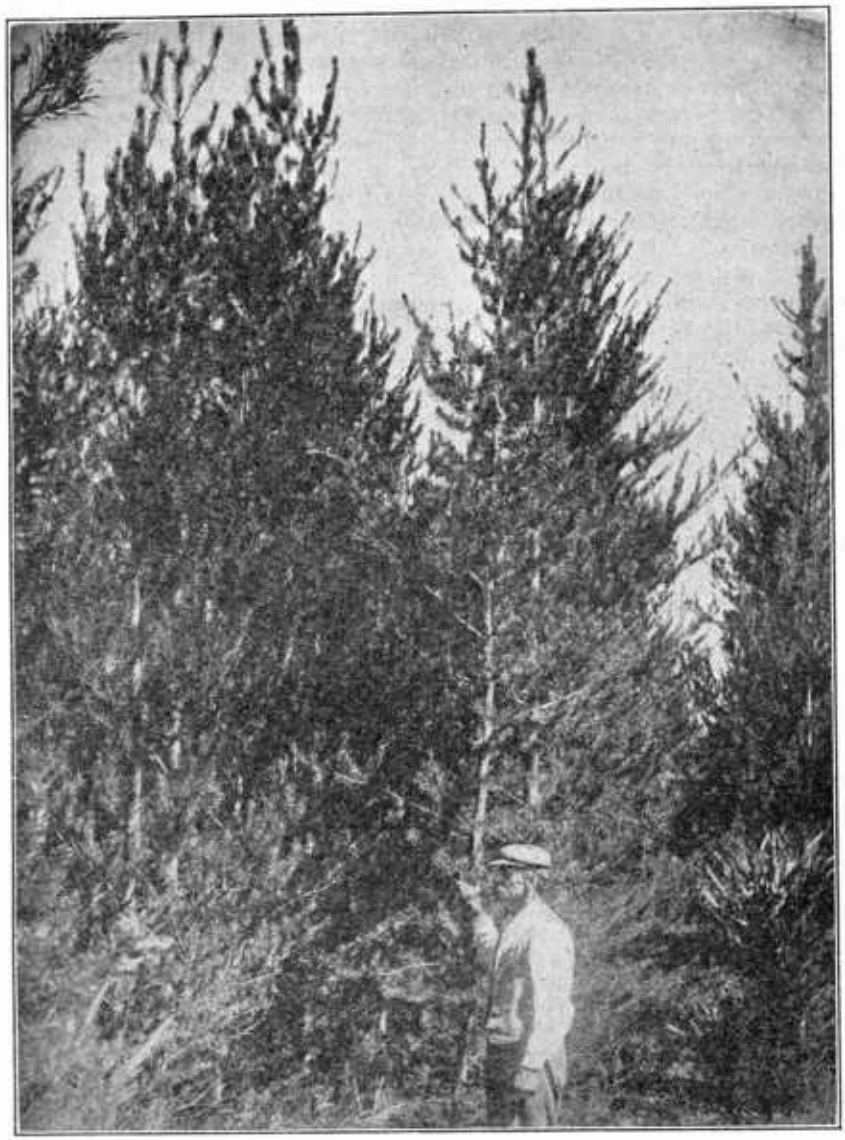

FIG. 18.—Jack pine plantation 14 years old. Height 12 to 24 feet. Holt County, Nebr.

farmer situated long distances from the railroad may be forced to use, may be given an average life of 20 years by treating them with creosote.[4]

[4] See U. S. Department of Agriculture Farmers' Bulletin No. 744, "The Preservative Treatment of Farm Timbers."

SOURCES OF INFORMATION AND PLANTING STOCK.

The Clarke-McNary law, which was passed by Congress in 1924, provides for the cooperation of the Federal Government with the States in the distribution of forest-tree seeds and plants for the purpose of establishing windbreaks, shelter belts, and farm wood lots. There is also provision for the cooperation of the Government with the States in assisting the owners of farms in establishing, improving, and renewing wood lots, shelter belts, and windbreaks. Under this law most of the States in the Great Plains region are now in a position to sell trees for plantings of this kind. Trees that are raised at State or Government nurseries can be purchased from the State officials indicated below at very reasonable rates.

In addition, most of the States now have farm foresters in their extension service, who advise farmers on the best methods of planting and the species to use.

The Northern Great Plains Field Station at Mandan, N. Dak., furnishes some forest-tree stock to dry-land farmers only in the western half of North Dakota and South Dakota and in eastern Montana and Wyoming for cooperative experimental plantings. Further information may be obtained by writing the Northern Great Plains Field Station, Mandan, N. Dak.

Trees and shrubs for ornamental and street tree planting should be purchased from commercial nurserymen.

Information about planting and trees for shelter belt and woodlot planting may be obtained from the following sources:

NORTH DAKOTA.—State Forester, Bottineau, N. Dak.
Northern Great Plains Field Station, Mandan, N. Dak.
SOUTH DAKOTA.—State College of Agriculture, Brookings, S. Dak.
Northern Great Plains Field Station, Mandan, N. Dak.
MONTANA.—State Forester, Missoula, Mont.
Northern Great Plains Field Station, Mandan, N. Dak.
District Forester, Missoula, Mont.
WYOMING.—College of Agriculture, University of Wyoming, Laramie, Wyo.
Northern Great Plains Field Station, Mandan, N. Dak.
NEBRASKA.—Extension Director, College of Agriculture, Lincoln, Nebr.
Forest Supervisor, Halsey, Nebr.
COLORADO.—State Forester, Fort Collins, Colo.
District Forester, Denver, Colo.
KANSAS.—State Forester, Manhattan, Kans.
Fort Hays Experiment Station, Hays, Kans.
OKLAHOMA.—State Forester, Oklahoma City, Okla.
Woodward Field Station, Woodward, Okla.
Agricultural Experiment Station, Stillwater, Okla.
NEW MEXICO.—College of Agriculture, State College, N. Mex.
Tucumcari Field Station, Tucumcari, N. Mex.
District Forester, Albuquerque, N. Mex.
TEXAS.—State Forester, College Station, Tex.

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June 15, 1927

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